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Body condition scoring and weight estimation of horses

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Summary

Three hundred and seventy two horses of varying breeds, height and fatness were weighed and measured for height at the withers. They were assessed for condition score by adaptation of a previously published method. The heart girth and length of 281 of the horses were also measured. Weight of horses was highly correlated ($P<0.001$) with height ($r^2=0.62$), condition score ($r^2=0.22$) and girth^2 x length ($r^2=0.90$). Nomograms were constructed to predict weight from height and condition score, and girth and length measurements. Weight can also be accurately estimated from the formula:-

$$\text{Weight (kg)} = \frac{\text{girth}^2 \times \text{length (cm)}}{[Y]}$$

The average value of 'Y' in this experiment was 11900 and this estimated weight with more accuracy than some previously published values of 'Y'. Racing Thoroughbred horses were found to be significantly lighter than non-racing Thoroughbreds of the same height and condition score. The method of assessment of condition score was shown to be repeatable between different operators with varying degrees of experience.

Introduction

MANY horse owners fail to recognise significant variation in the weight of horses, due to changes in body condition or variation due to age and breed types. This often results in underfeeding or overfeeding. Weighing scales suitable for horses are rarely available and therefore estimation of bodyweights by owners and veterinarians is required for administration of anthelmintics, anaesthetics and other drugs. Traditional methods of weight estimation rely on calculation from a formula using girth and length measurements (Milner and Hewitt 1969; Hall 1971; Ensminger 1977; Leighton-Hardman 1980).

Body condition scoring is an alternative method utilised extensively as a management aid in sheep (Russel 1984), dairy cattle (Earle 1976) and beef cattle (Graham 1982). Body condition scoring of horses involving palpable and visual assessment of the degree of fatness of the neck, back, ribs and pelvis has been described by Leighton-Hardman (1980) and Henneke, Potter, Kreider and Yeates (1983). The purposes of this work were: 1) to obtain reliable estimates of bodyweight from linear measurements and condition score of a large number of horses of variable fatness; 2) to establish standards for the procedure of condition score measurement.

Materials and methods

Three hundred and seventy two horses and ponies were weighed using a Sensi-Weigh Cattle Scale (J. W. Wedderburn & Sons, Thornbury, Victoria, Australia), had their height measured at the withers and were assessed for condition score. The accuracy of the scale was checked on each occasion by calibration with a known 80 kg weight. The horse's height was measured at the highest point of the withers with the horse standing squarely on a level surface and the head in a normal position. The condition scoring system was adapted from that published by Leighton-Hardman (1980) (Table 1). In addition, heart girth and length from the point of the shoulder to the tuber ischii (point of buttocks) were measured in 281 of the horses. Girth was measured immediately posterior to the elbow following respiratory expiration. The weight was recorded to the nearest kilogram, height measured in hands and then converted to centimetres and the length and girth measurements were recorded to the nearest centimetre.

This study examined Thoroughbred racehorses, non-pregnant Thoroughbred broodmares, Standardbreds, horses used by Mounted Police and pony clubs, ponies and other breeds. They ranged in height from less than 12 hands (122 cm) to more than 17 hands (173 cm) (Fig 1). Their condition scores (CS) ranged from 1 to 5 with 3.5 being the most prevalent score. The following groups each contained over 50 horses: CS 2.5, CS 3, CS 3.5, CS 4; whereas CS 1, CS 1.5 and CS 2 contained between 10 and 50 horses each. CS 4.5 and CS 5 contained less than 10 horses. The weights recorded ranged from 160 to 680 kg. Each 20 kg range between 280 kg and 640 kg contained at least 10 horses. The median weight range was 460 to 479 kg.

The horses were placed into five height categories (12 hand [122-131 cm], 13 hand [132-141 cm], 14 hand [142-151 cm], 15 hand [152-162 cm], 16 hand [163-172 cm]) and then grouped according to condition score. Average weight, standard error and confidence limits were calculated for each group. No horses were measured in the 13 hand (132-141 cm) CS 1 group or the (14 hand (142-151 cm) CS 5 group. The small number of results did not allow confidence limit calculation in the following groups: 12 hand (122-131 cm) CS 1, 12 hand (122-131 cm) CS 5, 13 hand (132-141 cm) CS 5, 14 hand (142-151 cm) CS 1, 16 hand (163-172 cm) CS 5.

Previous formulae (Milner and Hewitt 1969; Hall 1971; Ensminger 1977; Leighton-Hardman 1980) were compared with our calculations for the divisor 'Y' in the horse weight prediction equation:-

$$\text{Weight (kg)} = \frac{\text{girth}^2 \times \text{length (cm)}}{[Y]}$$

Correlations were calculated between weight and height, girth, length, condition score and girth^2 x length. The correlation between condition score and 'Y' was also calculated. Regression analyses of weight against height and condition score, and weight against girth^2 x length were used to construct nomograms for prediction of weight. The nomograms were constructed according to the procedure described by Smith (1968).

In a separate experiment, 20 non-pregnant Thoroughbred mares were weighed, condition scored and had their height

TABLE 1: Body Condition Score System

	Neck	Back and Ribs	Pelvis
0 Very Poor	Marked 'ewe' neck Narrow and slack at base	Skin tight over ribs Spinous processes sharp and easily seen	Angular pelvis – skin tight Deep cavity under tail and either side of croup
1 Poor	'Ewe' neck Narrow and slack at base	Ribs easily visible Skin sunken either side of backbone. Spinous processes well defined	Rump sunken, but skin supple Pelvis and croup well defined Deep depression under tail
2 Moderate	Narrow but firm	Ribs just visible. Backbone well covered Spinous processes felt	Rump flat either side of backbone Croup well defined, some fat Slight cavity under tail
3 Good	No crest (except Stallions) Firm neck	Ribs just covered – easily felt No 'gutter' along back Spinous processes covered, but can be felt	Covered by fat and rounded No 'gutter' Pelvis easily felt
4 Fat	Slight crest Wide and firm	Ribs well covered - need firm pressure to feel 'Gutter' along backbone	'Gutter' to root of tail Pelvis covered by soft fat – felt only with firm pressure
5 Very Fat	Marked crest Very wide and firm Folds of fat	Ribs buried – cannot feel Deep 'gutter' Back broad and flat	Deep 'gutter' to root of tail Skin distended Pelvis buried – cannot feel

Adjust the pelvis score by 0.5 point if it differs by 1 or more points from the back or neck scores to obtain the condition score. (Adapted from Leighton-Hardman 1980.)

recorded by the studfarm manager. Independent condition scoring by one author and other horsemen was carried out twice using 15 horses on both occasions. The other horsemen had no prior familiarity with the condition scoring system.

Results

The means of weight and error bars of twice the standard error are shown in Fig 1 for each condition score group in a height range. Height and condition score were positively correlated with weight.

Nomograms for prediction of weight from height and condition score and from girth and length are shown in Figs 2 and 3. In both cases the relationship was significant ($P<0.001$), with the regression equation used to construct the girth and length nomogram having a slightly higher correlation ($r^2=0.837$ *vs* 0.825) and a lower standard error (se=37.2 *vs* 42.7).

Highly significant correlations ($P<0.001$) were found between weight and all factors measured (Table 2). Girth^2 x length was the most highly correlated factor measurement. When grouped in height ranges the correlation between condition score and weight increased. Condition score was not closely related with 'Y' ($r^2=0.08$).

The average value of 'Y' was 11877.4 cm^3/kg. This is listed in Table 3 for comparison with previously published values. When grouped according to condition score, the only significant difference in 'Y' between adjacent condition scores was between CS 2.5 and CS 3. Horses having condition scores less

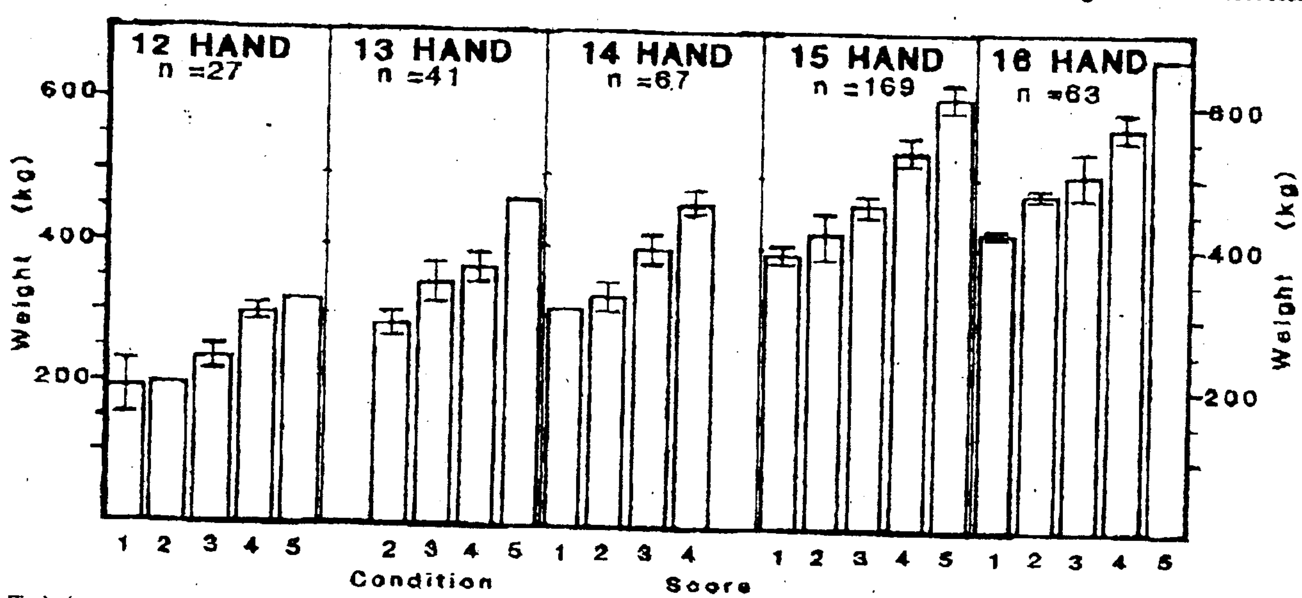

Fig 1. Average weight of horses of each condition score in height ranges (error bars show twice the standard error)

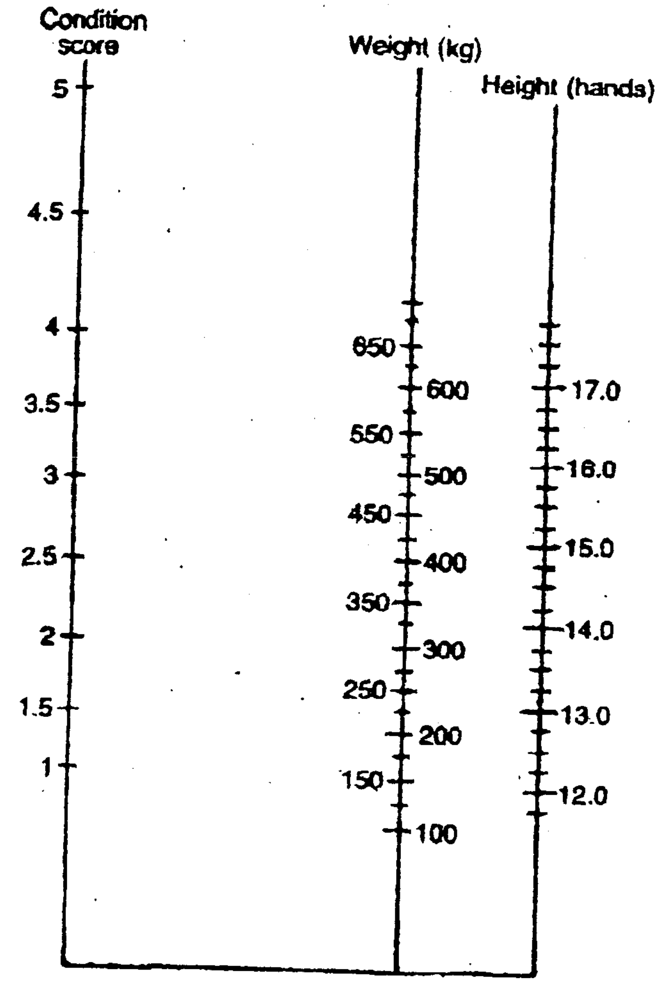

Fig 2. Nomogram for estimation of bodyweight from condition score and height measurement

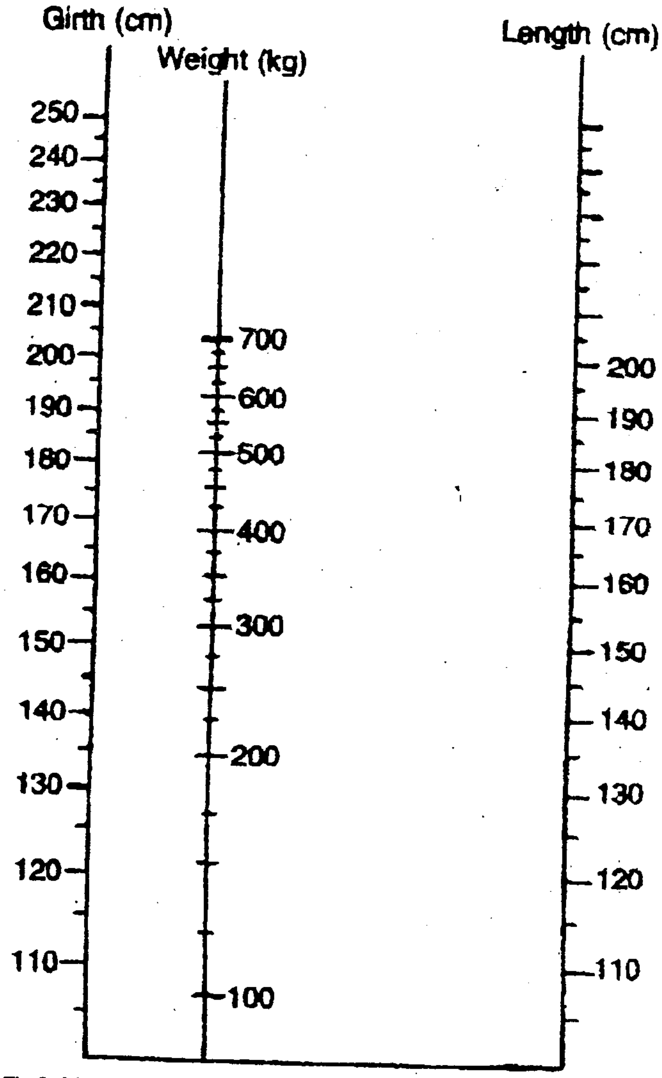

Fig 3. Nomogram for estimation of bodyweight from girth and length measurements

than 3 had a higher average value for 'Y' than those of condition score 3 or above (12265 *vs* 11706).

A comparison of the average weights of racing and non-racing Thoroughbreds is shown in Table 4. In all groupings, significant differences ($P<0.05$) were noted in average weight between racehorses and non-racehorses of the same height and condition score.

The Thoroughbred racehorses were grouped according to sex and no significant difference ($P>0.05$) was seen amongst the average weights of geldings (460.0 kg), colts (451.1 kg), and fillies and mares (449.8 kg).

The independently assessed group of Thoroughbred mares varied little in height and their condition score was highly correlated with weight ($r^2=0.704$, $P<0.001$). The average weight of mares of each condition score within the 15.0 to 15.3 hand (152 to 162 cm) and 16.0 to 16.3 hand (163 to 172 cm) ranges was calculated in the independently assessed group and this was compared with the average weight of horses of the same height and condition score in the authors' sample. No significant difference in weight was present between comparable groups in the independent sample and the authors' sample indicating accurate use of the condition scoring system.

Good correlation was present between the condition score results of one author and other horsemen when scoring 30 horses. The condition scores were the same in 65 per cent of horses and the maximum difference was 0.5 point.

Discussion

The body condition scoring system used in this study provided an objective assessment of body condition. The 0 to 5 system described was adapted from that used by Leighton-Hardman (1980) and was preferred to the 1 to 8 system used by Henneke *et al* (1983). A 0 to 5 system is also used in sheep (Russel 1984) and beef cattle (Graham 1982) condition scoring and the 0 to 5 horse system was considered simpler to use. The method used for assessing body condition takes into account the deposition of body fat in different areas by separate examination of the neck, back, ribs, pelvis and rump. Individual horses deposit their body fat in different areas of the body, and this method takes account of the whole body; and individual neck, ribs and rump assessments are then combined to give an overall condition score. By itself, condition score was not closely related to weight, but when height was constant, bodyweight was highly correlated with condition score. Henneke *et al* (1983) found that condition score was more closely related to body fat content than any other single physical measurement. The method was shown to be repeatable when used by horsemen with no previous experience of the system, and this

TABLE 2: Correlations (r^2) between weight and physical measurements

Girth	0.87***
Length	0.75***
Height	0.62***
Condition score	0.22***
Girth^2 x length	0.90***
Girth x height	0.84***
Girth x length x height	0.85***
Height x condition score	0.45***

***P<0.001

repeatability has also been shown in other species (Graham, Clark and Spiker 1982).

Deviations from the desired body condition and changes in workload, pregnancy and lactation are the main factors which influence the feed requirements of a horse. Condition scoring can be used to monitor the response to changes in the horse's feed intake.

If a horse's condition score and approximate height are known, the weight of the horse can be estimated as shown in Fig 1. Use of the height condition score nomogram (Fig 2) will increase accuracy as the exact height and condition score can be used to calculate the weight. The girth length nomogram (Fig 3) will provide the most accurate method of weight estimation as girth and length are the factors most closely correlated with weight.

Effective use of the weight prediction nomograms depends on accurate body measurements and condition score estimation. Girth measurement errors and condition score errors lead to greater inaccuracy than do length or height measurement errors. However, if height is estimated rather than measured, considerable inaccuracies can occur. Measurement or assessment inaccuracies lead to weight estimation errors of greater magnitude in both fatter and heavier horses than in thinner and lighter horses. Factors influencing height measurement include having the horse relaxed, standing squarely on a level surface with the head in the normal position and making allowance for shoes (Hickman and Colles 1984). For maximum accuracy in measuring length, two people are required to hold the tape. A 2 m tape is sufficient for all but the largest horses when girth can exceed 2 metres. Use of the nomogram for weight prediction cannot take account of changes due to hydration or variation in the weight of intestinal contents. Up to 5 per cent dehydration may be clinically undetectable (Carlson 1983) and the gastrointestinal tract proportion of body weight may vary from 5 to 20 per cent depending upon the time since feeding and the feed type (Webb and Weaver 1979).

The divisor 'Y' in the traditional formula for weight estimation is similar to the value reported by Hall (1971). Use of this formula provides an accurate method of weight estimation, but it is more cumbersome to use than the nomogram. It cannot be compared to the value of Milner and Hewitt (1969), where

TABLE 3: Weight estimation by measurement of girth and length and comparison of authors' results with published 'Y' values

Source	Metric	Imperial
	(cm^3/kg)	($inches^3$/lb)
Authors' results	11877.4	329.5
Hall	11880.0	330.0
Ensminger[a]	10815.0	300.0
Leighton-Hardman[b]	10488.0-10912.0	291.0-303.0

[a]Add constant of 22.7kg (50lb);
[b]Value chosen depends on breed or sex of horse

TABLE 4: Comparison of average weights of racing and non-racing Thoroughbred horses

Height (hands)	15.0-15.3H		15.0-15.3H		16.0-16.3H		16.0-16.3H	
	Race		Non-race		Race		Non-race	
Condition Score	n	Wt	n	Wt	n	Wt	n	Wt
2.5	5	416.1*	9	458.9	4	438.8*	8	491.7
3	18	436.1***	10	484.1	6	480.7*	11	540.5
3.5	12	464.4***	28	517.9	6	484.8*	10	532.2
4	7	458.4***	22	556.1	2	512.0*	6	579.2

***P<0.001; **P<0.01; *P<0.05

length was measured to the point of the hip, or the Immobilon Dosage Calculator (Reckitt and Colman, England) where length is measured from the olecranon process. According to our results, application of the Leighton-Hardman (1980) formula would lead to a weight over estimation of 10 per cent whereas the Ensminger (1977) formula would over estimate weight to a greater extent because it incorporates an added constant of 22.7 kg. This could have serious consequences when calculating dosages of drugs which have a low safety margin.

It has been suggested that the value for 'Y' should be increased for low condition score horses and decreased for high condition scores horses in an almost linear manner (Leighton-Hardman 1980). The authors found that the only significant difference in 'Y' between adjacent condition score groups was between score 2.5 and 3.0. In no case did the values of Leighton-Hardman (1980) fall within the confidence limits (P>0.05).

Retired Thoroughbred racehorses were found to be significantly heavier than their racing counterparts of the same height and condition score. A decrease in weight during training due to a reduction in fat cover has been reported by Snow, Munro and Nimmo (1982). Age would account for some of the appreciable difference as 90 per cent of the racehorses were two- or three-year-olds and the non-racehorses were mainly mature horses. Increases in the weight of intestinal contents caused by the roughage based diet fed to the non-racing group may also be important. The height and condition score nomogram will over estimate the weight of racing animals and it should not be used, whereas the girth and length scale is suitable for weight estimation.

No significant sex differences in weights were found in racing horses which is not surprising given the finding that Thoroughbred colts and fillies had no significant difference in their height and girth up to three years of age (Green 1976).

Condition scoring can be used as a repeatable and objective method of assessing a horse's body condition. This is essential for instituting appropriate feeding management and monitoring the effect of different feeding regimes. It can be used with height estimation or measurement to provide a useful weight estimate that is almost as accurate as that derived from the girth and length formula or nomogram.

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References

Carlson, G. P. (1983) Current Therapy in Equine Medicine. W. B. Saunders, Philadelphia. p 314.

Earle, D. (1976) A guide to scoring dairy cow condition. *J. Agric. Victoria* **4**, 228-231.

Ensminger, M. E. (1977) Horses and Horsemanship. 5th edn. Interstate Printers and Publishers, Danville. p 509.

Graham, J. F. (1982) Condition Scoring of Beef Cattle *Vic. Dept. Agric.* 1859/82.

Graham, J. F., Clark, A. J. and Spiker, S. A. (1982) The repeatability and accuracy of condition scoring beef cattle. *Proc. Aust. Soc. Anim. Prod.* **15**, 684.

Green, D. A. (1976) Growth rate in Thoroughbred yearlings and two-year-olds. *Equine vet. J.* **8**, 133-134.

Hall, L. W. (1971) Wrights Veterinary Anaesthesia and Analgesia. 7th edn. Baillière Tindall, London. p 176.

Henneke, D. R., Potter, G. D., Kreider, J. L. and Yeates, B. F. (1983) Relationship between condition score, physical measurement and body fat percentage in mares. *Equine vet. J.* **15**, 371-372.

Hickman, J. and Colles, C. (1984) Measurement of horses. *Vet. Rec.* **114**, 491-493.

Leighton-Hardman, A. C. (1980) Equine Nutrition. Pelham Books. London. p 9-17.

Milner, J. and Hewitt, D. (1969) Weights of horses: Improved estimates based on girth and length. *Can. vet. J.* **10**(12), 314-316.

Russel, A. (1984) Body condition scoring of sheep. *In Practice* **6**, 91-93.

Smith, C. A. B. (1968) Biomathematics: The principles of mathematics for students of biological general science. 4th edn. C. Griffin. London. p 163.

Snow, D. H. Munro, C. D. and Nimmo, M. A. (1982) Effects of nandrolone phenylpropionate in the horse: (2) General effects in animals undergoing training. *Equine vet. J.* **14**, 224-228.

Webb, A. I. and Weaver, B. M. (1979) Body composition of the horse. *Equine vet. J.* **11**, 39-47.

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